IN THE CLAIMS:

The following list of claims replaces all prior listings and versions of claims in this application:

1. (Currently amended) A method for producing a high quality useful layer of semiconductor material on a substrate, which comprises:

implanting at least two different atomic species into a face of a donor substrate to a controlled mean implantation depth to form a weakened zone therein and to define a useful layer~~, the implanting step being conducted to minimize low-frequency roughness at the weakened zone~~;

bonding a support substrate to the face of the donor substrate;

detaching the useful layer from the donor substrate along the weakened zone to form a structure that includes the useful layer on the support substrate with the useful layer presenting a useful layer surface for further processing, wherein the different atomic species are implanted to minimize low-frequency roughness of the useful layer surface; and

thermally treating the structure to minimize high-frequency roughness of the useful layer surface ~~of the useful layer~~ to thus provide ~~a surface having~~ sufficient smoothness so that chemical mechanical polishing of the useful layer surface is not required.

2. (Original) The method of claim 1 wherein the different species comprises hydrogen species and helium species.

3. (Original) The method of claim 2 which further comprises sequentially implanting the hydrogen and helium species.

4. (Original) The method of claim 3 which further comprises implanting the helium species before implanting the hydrogen species.

5. (Original) The method of claim 2 wherein the helium species is implanted at a dose of between about 0.5×10^{16} cm^{-2} and about 1.5×10^{16} cm^{-2}.

6. (Original) The method of claim 2 wherein the hydrogen species is implanted at a dose of between about 0.5×10^{16} cm^{-2} and about 2.5×10^{16} cm^{-2}.

7. (Original) The method of claim 1 wherein the thermal treatment is a rapid thermal annealing process carried out at a temperature of between about 800°C and 1400°C.

8. (Original) The method of claim 7 wherein the rapid thermal annealing process is carried out for a duration of about 1 to about 60 seconds.

9. (Original) The method of claim 7 wherein the rapid thermal annealing process is conducted in an atmosphere comprising a mixture of argon and hydrogen.

10. (Original) The method of claim 7 wherein the rapid thermal annealing process is conducted in an atmosphere of pure argon.

11. (Original) The method of claim 7 wherein the rapid thermal annealing process is conducted in an atmosphere of pure hydrogen.

12. (Original) The method of claim 1 which further comprises conducting at least one stabilized oxidation process on the structure.

13. (Original) The method of claim 12 wherein the stabilized oxidation process comprises successive implementations of an oxidation operation, an annealing operation and a deoxidation operation.

14. (Original) The method of claim 13 which further comprises conducting the annealing operation for about two hours at a temperature of about 1100°C.

15. (Original) The method of claim 12 which further comprises conducting a rapid thermal annealing process on the structure prior to the stabilized oxidation process.

16. (Original) The method of claim 12 which further comprises conducting a plurality of rapid thermal annealing and stabilized oxidation processes on the structure.

17. (Original) The method of claim 12 wherein the stabilized oxidation operation is conducted prior to thermally treating the structure.

18. (Original) The method of claim 17 which further comprises conducting a plurality of stabilized oxidation and rapid thermal annealing processes on the structure.

19. (Original) The method of claim 1 which further comprises at least one simple oxidation operation including an oxidation operation followed by a deoxidation operation of the structure.

20. (Original) The method of claim 19 which further comprises conducting a rapid thermal annealing process prior to the simple oxidation operation.

21. (Original) The method of claim 19 which further comprises conducting a plurality of rapid thermal annealing and simple oxidation processes on the structure.

22. (Original) The method of claim 19 wherein the simple oxidation is conducted prior to a rapid thermal annealing process.

23. (Original) The method of claim 22 which further comprises conducting a plurality of simple oxidation and rapid thermal annealing processes on the structure.

24. (New) The method of claim 1, wherein the different atomic species are implanted so that the useful layer surface is provided with a low-frequency roughness of less than about 5 Å after the detachment of the useful layer at the weakened zone without chemical mechanical polishing.

25. (New) The method of claim 24, , wherein the different atomic species are implanted so that the useful layer surface is provided with a low-frequency roughness of

less than about 5 Å measured over a sweep area of about 40 x 40 μm^2 after the detachment of the useful layer at the weakened zone without chemical mechanical polishing.

26. (New) The method of claim 5, wherein the helium species is implanted at a dose of about 0.9×10^{16} cm^{-2} or less.

27. (New) The method of claim 26, wherein the hydrogen species is implanted at a dose of between about 0.5×10^{16} cm^{-2} and about 0.9×10^{16} cm^{-2}.

28. (New) The method of claim 8, wherein the rapid thermal annealing process is conducted in an atmosphere comprising pure argon or hydrogen or a mixture thereof.